ioSci
9
E21
0.527

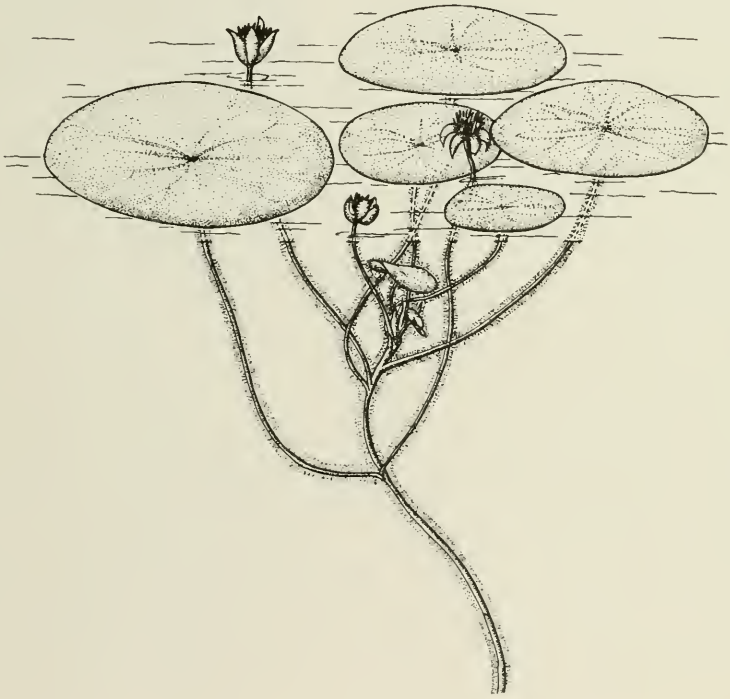
ATION BULLETIN 527 March, 1984

BIO SCI
LIBRARY

quatic Vascular Plants of New England: Part 7. Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae

by

C. B. Hellquist and G. E. Crow



NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824

ISSN: 0077-8338

University of New Hampshire Library

SHOUT
SHARE
IT

ioSci
9
E21
0.527

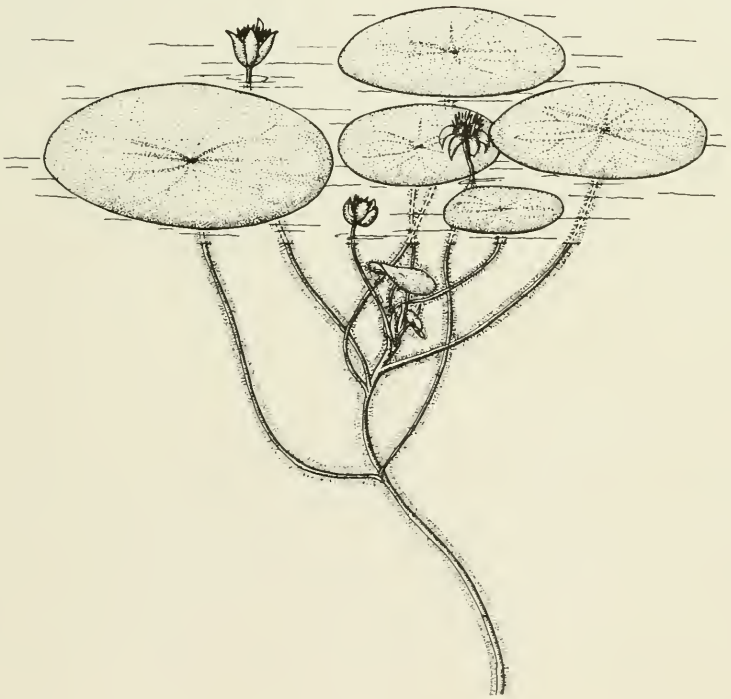
ATION BULLETIN 527 March, 1984

BIO SC
LIBRAR

quatic Vascular Plants of New England: Part 7. Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae

by

C. B. Hellquist and G. E. Crow



NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824

S
89
.E21
no.527

ACKNOWLEDGEMENTS

We wish to thank Edward G. Voss, Carroll E. Wood, and Donald H. Les for their helpful comments on the manuscript. We are also grateful to the curators of the following herbaria for use of their collections: BRU, CONN, CUW, GH, HNH, KIRI, MASS, MAINE, NASC, NCBS, NHA, NEBC, VT, YU. A special thanks is extended to Pamela Bruns Brayton who prepared the illustrations. Permission to redraw some figures from Fassett's *Manual of Aquatic Plants* used in Figure 7 was kindly provided by the University of Wisconsin Press.

This work is a result of research sponsored by the New Hampshire Agricultural Experiment Station. The NHAES reserves the right to reproduce, publish or otherwise use, and to authorize others to use, the work for Government purposes notwithstanding notice of copyright.

Copyright © 1984 by the University of New Hampshire. No part of this work may be reproduced in any manner without permission from the authors and the University of New Hampshire.

Programs of the New Hampshire Agricultural Experiment Station are open to all persons without regard to race, color, national origin or sex. The University of New Hampshire is an Affirmative Action/Equal Opportunity Employer.

UNH LIBRARY
3 4600 00618 4755

ABSTRACT

This paper is the seventh in a series of reports on the aquatic and wetland flora of New England. It treats all species of the Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae occurring in New England and includes keys, comments on taxonomy and nomenclature, habitat and distributional information, water chemistry data, illustrations, and dot maps. Those species regarded as rare and endangered in the New England Region or in one or more of the six New England States are also noted. One species, *Nymphaea tetragona*, is presently under consideration by the U.S. Fish and Wildlife Service for listing under the Endangered Species Act of 1973.

KEY WORDS: Aquatic Plants, New England Flora, Taxonomy, Cabombaceae, Nymphaeaceae, Nelumbonaceae, Ceratophyllaceae, *Cabomba*, *Brasenia*, *Nymphaea*, *Nuphar*, *Nelumbo*, *Ceratophyllum*, Fanwort, Water-shield, Water-lily, Pond-lily, Yellow Water-lily, Spatterdock, Cow-lily, Lotus, Water Chinquapin, Coontail, Hornwort.

TABLE OF CONTENTS

Page

INTRODUCTION 1

CABOMBACEAE 2

Cabomba 2

Cabomba caroliniana 2

Brasenia 2

Brasenia schreberi 6

NYMPHAEACEAE 6

Nymphaea 6

Key to Species 6

Nymphaea odorata 9

Nymphaea tuberosa 9

Nymphaea tetragona 9

Nuphar 10

Key to Species 10

Nuphar pumila 13

Nuphar × *rubrodisca* 13

Nuphar variegata 13

Nuphar advena 19

NELUMBONACEAE 19

Nelumbo 19

Nelumbo lutea 19

CERATOPHYLLACEAE 19

Ceratophyllum 19

Key to Species 21

Ceratophyllum demersum 21

Ceratophyllum echinatum 21

Literature Cited and Selected References 24

Aquatic Vascular Plants of New England: Part 7. Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae

by

C. B. Hellquist and G. E. Crow[1]

INTRODUCTION

This is the seventh in a series of reports on the aquatic and wetland flora of New England. These reports are intended to aid conservationists, fish and game personnel, consultants, botanists, and students in the identification of aquatic plants. The coverage is strictly New England but is of value throughout the northeast. Data have been gathered from herbaria in New England and from personal field work.

The chemical data included represent samples from many waters throughout New England. The alkalinity readings are total alkalinity, expressed as milligrams per liter (mg/l) $CaCO_3$. The number of observations is given in parentheses following alkalinity and pH values. Since pH and alkalinity vary greatly during the day, the values are only indicative of the water quality.

The rare and endangered plant lists referred to are those prepared for each of the six New England states by the New England Botanical Club in cooperation with the United States Fish and Wildlife Service, Office of Endangered Species, Newton Corner, MA (RI — Church and Champlin, 1978; MA — Coddington and Field, 1978; VT — Countryman, 1978; ME — Eastman, 1978; CT — Mehrhoff, 1978; NH — Storks and Crow, 1978). Taxa indicated as rare, threatened or endangered for the entire New England Region are also noted (Crow *et al.*, 1981, Rhodora 83: 259-299).

We invite comments and/or criticisms on this treatment. Information on any species omitted or any additional localities will be welcomed. If anyone is interested in specific localities of any of the species indicated on the dot maps, please contact us.

[1]Dr. C. Barre Hellquist, Department of Biology, North Adams State College, North Adams, MA 01247.

Dr. Garrett E. Crow, Department of Botany and Plant Pathology, Nesmith Hall, University of New Hampshire, Durham, NH 03824.

CABOMBACEAE

1. Submersed leaves opposite, dissected into linear segments (fig. 1); floating leaves small, inconspicuous, oblong to linear-elliptic, peltate, less than 2 cm long, subtending flowers (fig. 1); submersed portions of plants lacking mucilaginous coating; flowers white to pinkish; stamens 3-6.
..... 1. *Cabomba*

1. Submersed leaves absent, except on young plants, then alternate (fig. 2B); floating leaves prominent, peltate, elliptical, 2-10 cm long (fig. 2); submersed portions of plants typically with a mucilaginous coating; flowers red-purple; stamens 12 or more.
..... 2. *Brasenia*

Cabomba (Fanwort)

Perennial, arising from short rhizomes with fibrous roots; submersed leaves opposite, petioled, fan-like, with finely dissected divisions; floating leaves alternate, small, oblong to linear-elliptic, peltate; flowers usually solitary, borne in axils of floating leaves; perianth white to pinkish, about 12 mm long; carpels (2-)3(-4), separate; fruit leathery, indehiscent, 3-seeded follicle.

1. *Cabomba caroliniana* Gray Fig. 1, Map 1

Locally abundant and weedy in acidic waters of southern New England. This aggressive weed was first reported in New England from Cranston, Rhode Island in 1933. Herbicides and mechanical harvesting have proven completely ineffective for controlling this species. Range extends from southern New Hampshire and Massachusetts west to New York, Pennsylvania, southern Michigan, southern Illinois, and Missouri, south to Florida, eastern Oklahoma, and eastern Texas.

alkalinity: mean 15.8; range 3.5-35.0 mg/l; (13)
pH: mean 6.5; range 5.9-6.8; (10)

Brasenia (Water Shield)

Perennial, arising from creeping rhizomes; all leaves floating (submersed leaves present only on young plants), elliptic, peltate; submersed parts typically covered with a thick, mucilaginous coating; flowers solitary, axillary; perianth red-purple, 12-20 mm long; carpels 4-10, separate; fruit a leathery, indehiscent, 1-2 seeded follicle.

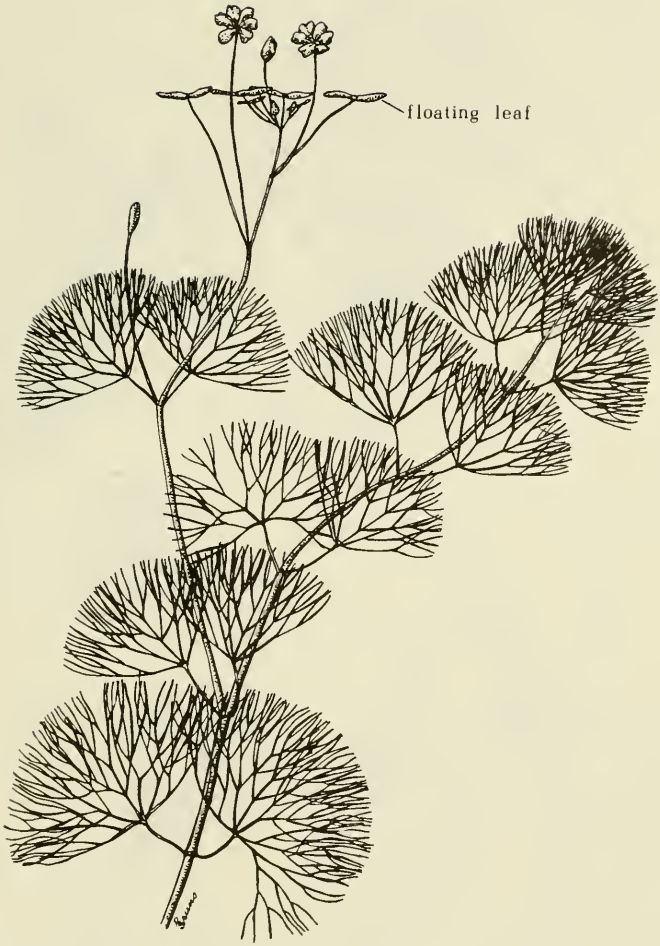
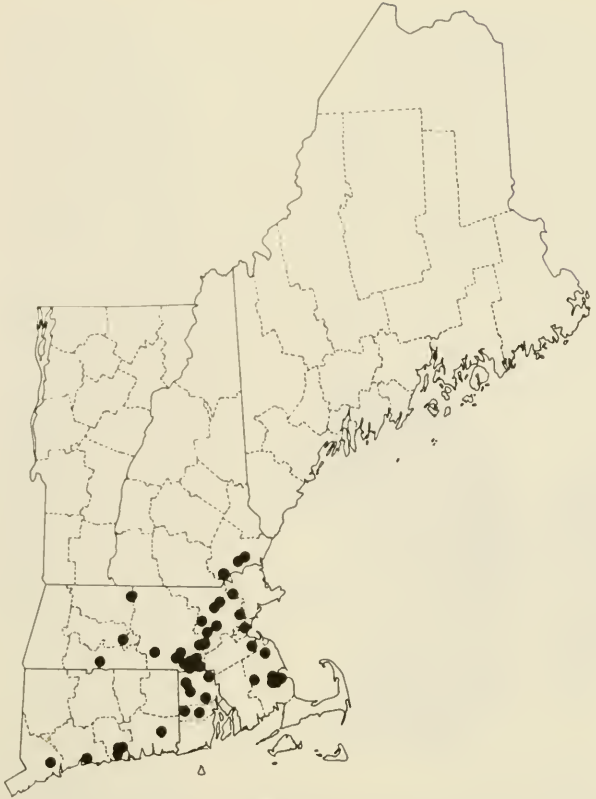
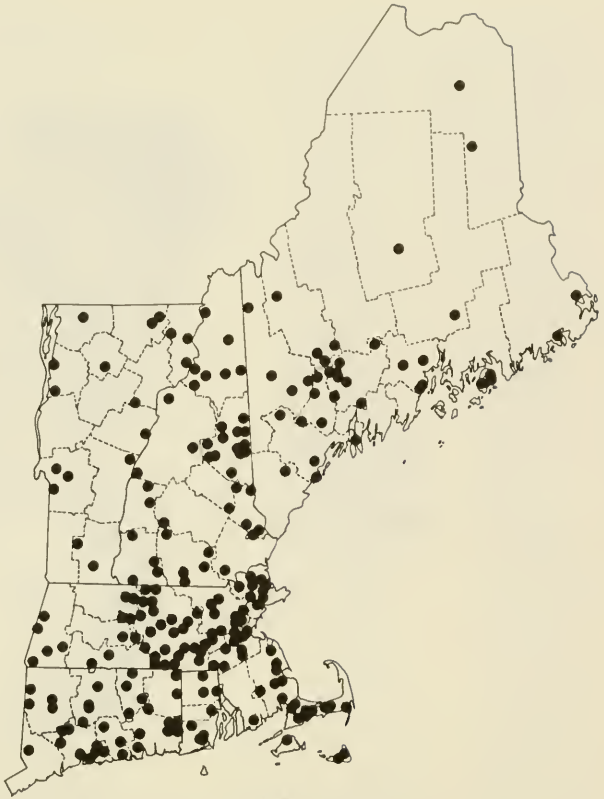


Figure 1.
Cabomba caroliniana: **habit × ½.**



Map 1.
Cabomba caroliniana



Map 2.
Brasenia schreberi

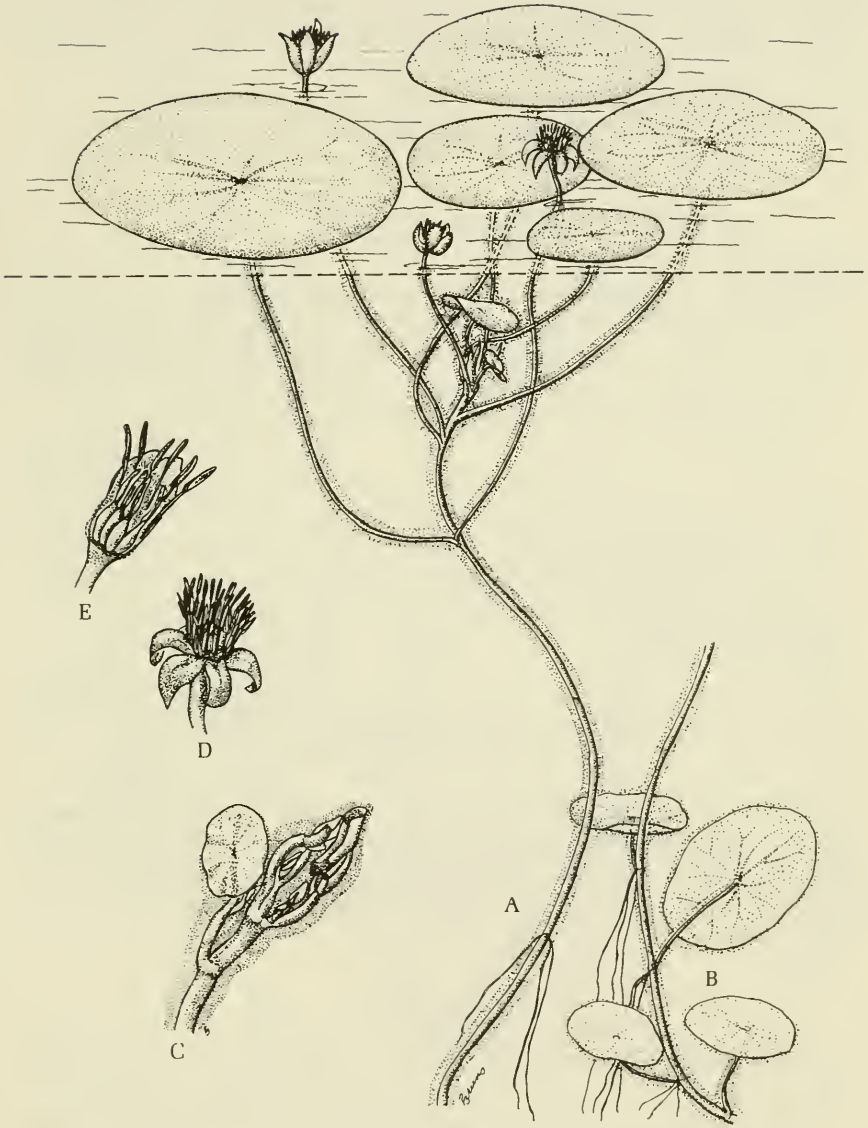


Figure 2.
Brasenia schreberi: A. habit × ½. B. submersed leaves of young plant × ½. C. winter bud with thick mucilaginous coating × ½. D. flower × 1. E. section of flower showing separate carpels × 1½.

1. *Brasenia schreberi* Gmel. Fig. 2, Map 2

Common in slow moving and standing waters throughout New England. Range extends from Prince Edward Island west to southern Quebec, southern Ontario, and Minnesota, south to Florida and Texas; southern British Columbia to Oregon; Mexico and Central America.

alkalinity: mean 15.9 mg/l; range 2.5-111.5 mg/l; (53)
pH: mean 6.6; range 5.7-9.5; (51)

NYMPHAEACEAE

1. Flowers white to pinkish, broadly open (figs. 3,4); sepals 4, greenish; petals numerous, conspicuous, elliptic to spatulate to oblanceolate; stigmas radiate from globose ovary summit extending into linear, incurved sterile appendages; leaves orbicular, lobes with recurved tips (fig. 3A,D), venation essentially palmate (fig. 3A,D).
..... 1. *Nymphaea*
1. Flowers yellow, sometimes greenish or reddish, subglobose (fig. 7); sepals 5-6(-9); petals numerous, strap-like, usually shorter than, but resembling the stamens, recurved; stigmas sessile, radiate on a disc (fig. 7), appendages lacking; leaves orbicular-reniform, ovate to oblong, lobes rounded at tip (figs. 5,6), venation essentially pinnate (fig. 5B,D).
..... 2. *Nuphar*

Nymphaea (Water-lily, Pond-lily)

Perennial, arising from rhizomes; leaves submersed, floating and/or emergent, deeply cleft, long-petioled; flowers showy; sepals 4, greenish; petals numerous, white to pink, the inner ones usually transitional to stamens; fruit a leathery berry; seeds arillate, maturing underwater.

Key to Species

1. Leaves orbicular to ovate in outline, 7-30 cm wide, sinus typically narrow or closed (fig. 3A,D); flowers 7-30 cm broad, petals 17-32.
2. Petioles green, not striped; lower surface of leaf red to purple (rarely green); petals elliptic, subacute at tip (fig. 3B,C).
..... 1. *N. odorata*
2. Petioles green with brown-purple stripes; lower surface of leaf green (rarely faint red-purple); petals spatulate to oblanceolate, rounded at tip (fig. 3E,F).
..... 2. *N. tuberosa*

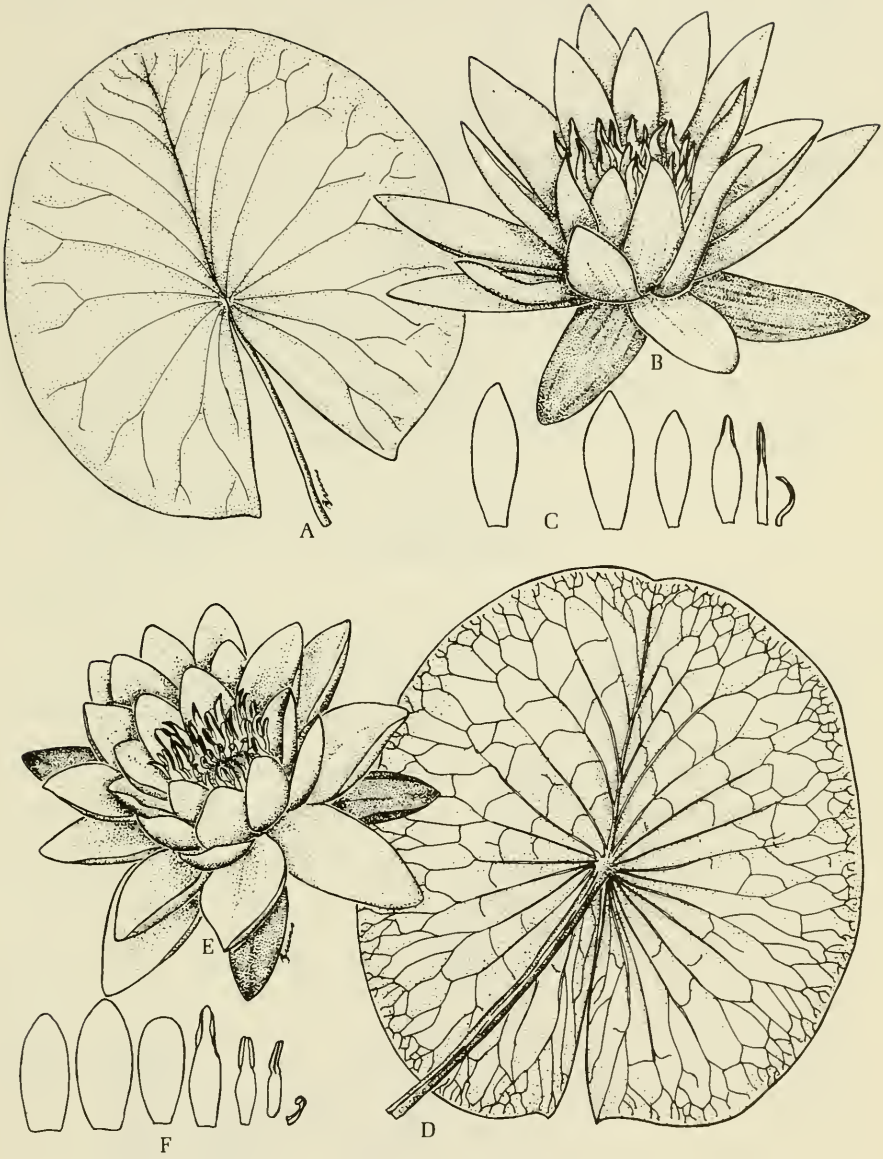
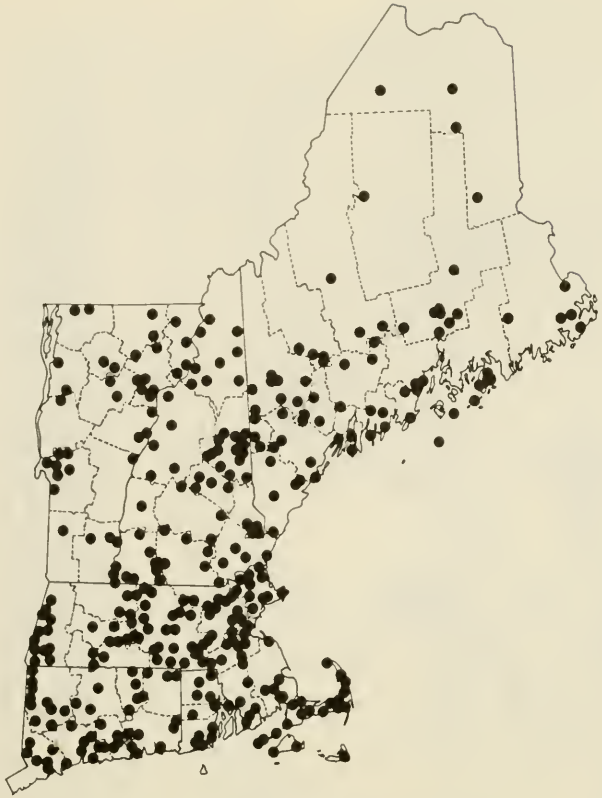
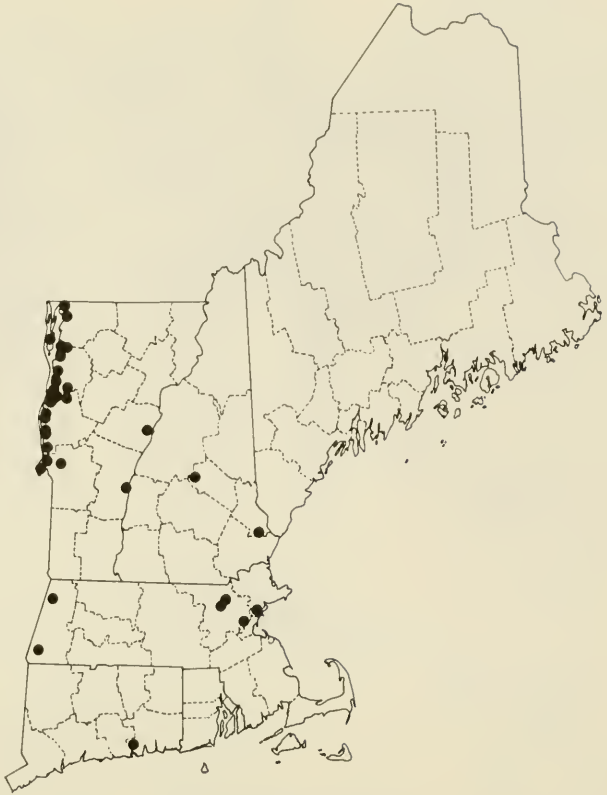


Figure 3.
Nymphaea odorata: **A. leaf × ½. B. flower × ½. C. series showing transition from petals to stamens × ¼.**
Nymphaea tuberosa: **D. leaf × ½. E. flower × ½. F. series showing transition from petals to stamens × ¼.**



Map 3.
Nymphaea odorata



Map 4.
Nymphaea tuberosa

1. Leaves ovate to obovate in outline, 4-9 cm wide, sinus typically open with widely divergent lobes (fig. 4); flowers 3.3-8 cm broad, petals 8-17.
..... 3. *N. tetragona*

1. *Nymphaea odorata* Ait. Fig. 3, Map 3

Extremely common throughout New England in sluggish streams, ponds, and lakes. Light pink-flowered individuals are frequently encountered and are treated by some authors as forma *rubra* Guillon. Occasionally plants with dark pink to light red flowers are found which are likely to be the European *Nymphaea alba* L. forma *rosea* Hartm., differentiated from *N. odorata* by having 20-24 petals which are rounded at the tips. Nymphaea odorata has 17-32 petals which gradually taper to subacute tips. Range extends from Newfoundland and southwestern Quebec west to Ontario, Minnesota, and Manitoba, south to Florida, Iowa, Nebraska, Kansas, Oklahoma, Texas, and Arizona.

alkalinity: mean 25.0 mg/l; range 2.0-141.5 mg/l; (121)
pH: mean 7.0; range 5.3-9.5; (117)

2. *Nymphaea tuberosa* Paine Fig. 3, Map 4

Common in alkaline waters of the Lake Champlain Valley of Vermont, uncommon elsewhere in New England, but sometimes planted as an ornamental. Floating leaves are often very large (up to 40 cm wide) and plants along the shoreline may have leaves elevated above the surface. Two characters often utilized to distinguish *N. odorata* and *N. tuberosa* are time of day flowers are open and the degree of flower odor. Neither of these traits are reliable. Population and transplant studies by Williams (1970) suggested that characters distinguishing *N. tuberosa* from *N. odorata* may not be constant. In calcareous waters of the Lake Champlain Valley the two taxa are easily distinguished. Likewise, introduced plants of *N. tuberosa* in acidic waters of eastern New England retain their distinctive features. Hence, we presently continue to recognize them as two species. Range extends from southwestern Quebec west to northern Ontario, Minnesota, and Nebraska, south to Maryland, Ohio, Indiana, Illinois, Arkansas, and northeastern Oklahoma.

Rare and endangered plant lists: Massachusetts, Connecticut

alkalinity: mean 59.0 mg/l; range 10.0-153.0 mg/l; (21)
pH: mean 7.6; range 6.8-8.6 (21)

3. *Nymphaea tetragona* Georgi Fig. 4, Map 5

Rare, in quiet streams and protected waters of moderate alkalinity of northern and northwestern Maine. The North American taxon

is subsp. *leibergii* (Morong) Porsild. Range extends from Quebec and northern Maine west to Isle Royale, Michigan, Saskatchewan, Northwest Territories, Alaska, and British Columbia, south to northwestern Montana, northern Idaho, and Washington.
Rare and endangered plant lists: Maine, New England; under consideration by the U.S. Fish and Wildlife Service, Office of Endangered Species for listing under the Endangered Species Act of 1973.

alkalinity: mean 24.8 mg/l; range 13.5-40.0 mg/l; (4)
pH: mean 7.1; range 7.0-7.3; (4)

Nuphar (Yellow Water-lily, Spatterdock, Cow-lily)

Perennial, arising from large, cylindrical, creeping rhizomes; leaves submersed when young, becoming floating and/or erect, blades deeply cleft, with long petioles; flowers globose, floating or elevated above surface; sepals 5-6(-9), yellow, sometimes greenish or reddish tinged; petals numerous, yellow, small, strap-like resembling the stamens; stamens numerous, filaments flat; stigmas sessile, radiate on a disc; fruit an ovoid, leathery berry, with numerous nonarillate seeds per locule, maturing above the water surface.

The treatment of *Nuphar* by E. O. Beal (1956), not followed here, recognized only one species, *N. lutea* (L.) Sibth. and Smith, in the world, with nine subspecies.

Key to Species

1. Leaf blades of mature plants 3.5-20 cm long, 3.5-14.5 cm wide; fruit conspicuously constricted below the stigmatic disc (fig. 7B,D).
   2. Flowers 2 cm or less wide; stigmatic disc with 6-10 deep crenations (fig. 7B), leaf blades 3.5-10 cm long, 3.5-7.5 cm wide; blade notch two-thirds or more the length of the midrib (fig. 5A).
      ..... 1. *N. pumila*
   2. Flowers 3 cm or more wide; stigmatic disc with 8-15 shallow crenations (fig. 7D); leaf blades 5-20 cm long, 4.5-14.5 cm wide; blade notch one-half the length of the midrib (fig. 5B).
      ..... 2. *N.* ×*rubrodisca*
1. Leaf blades of mature plants 7.0-40 cm long, 4.0-25 cm wide; fruit only slightly constricted, or not constricted below the stigmatic disc (fig. 7F,H).
   3. Petiole strongly flattened above and winged (fig. 6B); leaves usually floating (fig. 6A); fruit and inner surface of sepals often maroon or red.
      ..... 3. *N. variegata*

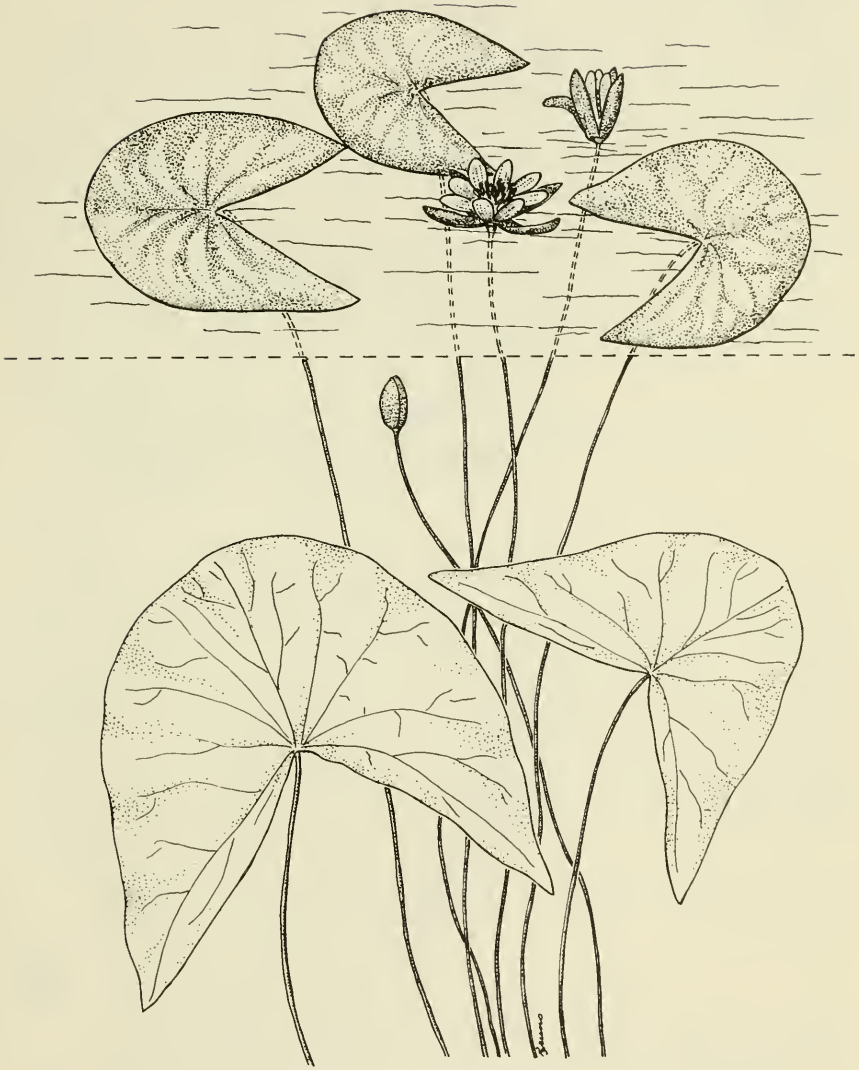
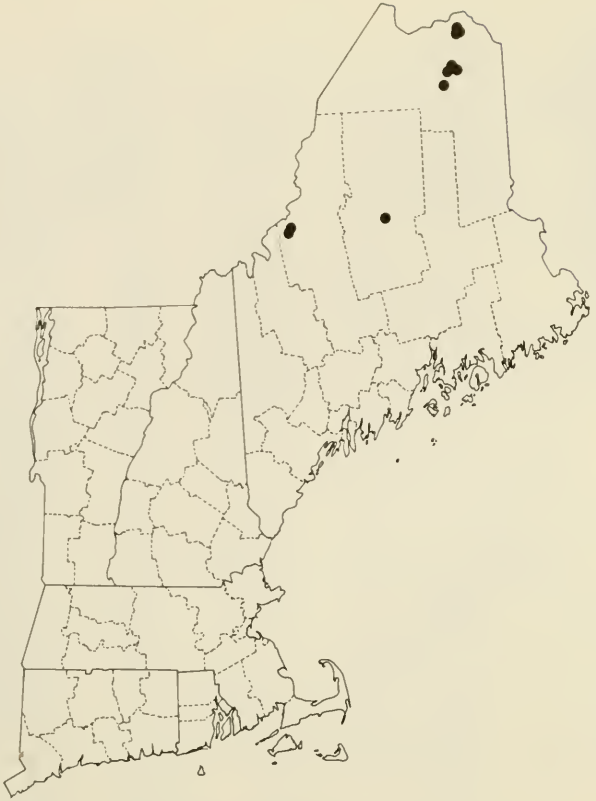
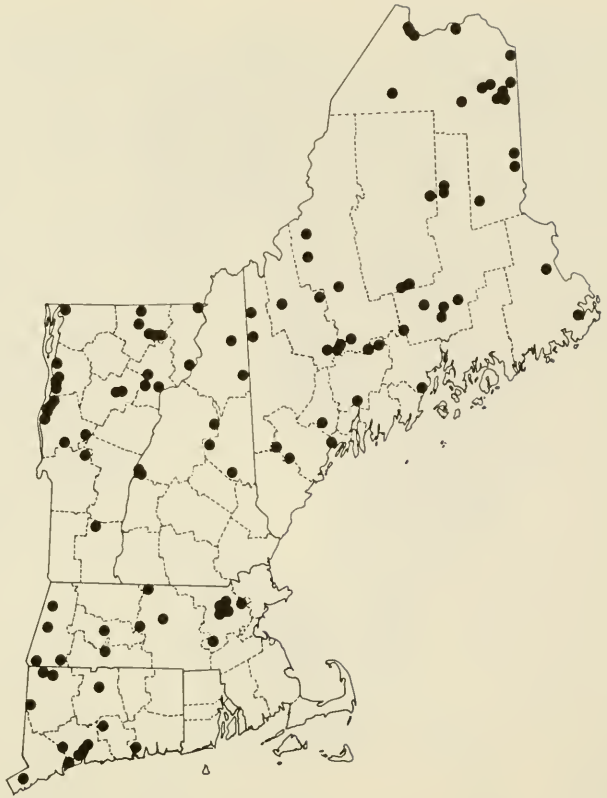


Figure 4.
Nymphaea tetragona: **habit showing both floating leaves and submersed leaves × ½.**



Map 5.
Nymphaea tetragona



Map 6.
Nuphar pumila

3. Petiole terete, not winged (fig. 5D); leaves mostly erect, elevated above the water surface (fig. 5C); inner surface of sepals and fruit green and/or yellow.
..... 4. *N. advena*

1. *Nuphar pumila* (Timm) DC. Figs. 5, 7, Map 6

Widely scattered in quiet waters of northern portions of Maine, New Hampshire, and Vermont; rare elsewhere in New England. This species once occurred more frequently throughout the region, but recent attempts to relocate it in southern New England have been unsuccessful. This taxon has long been treated as *N. microphyllum* (Pers.) Fern. More recently Beal (1956) has treated this as *N. lutea* subsp. *pumila* (Timm) Beal which also occurs in northern Europe. Range extends from Newfoundland west to Manitoba, south to Nova Scotia, northern Michigan, northern Wisconsin, and northeastern Minnesota.

Rare and endangered plant list: Maine
alkalinity: mean 36.1 mg/l; range 3.5-103.5 mg/l; (9)
pH: mean 7.4; range 6.5-9.5; (8)

2. *Nuphar* ×*rubrodisca* Morong Figs. 5, 7, Map 7

Widely scattered in quiet waters throughout New England, but especially common in the Lake Champlain Valley of Vermont. This taxon is believed to be a fertile hybrid between *N. pumila* and *N. variegata*. The stigmatic disc of the flower and fruit is usually bright red. Young plants of *N. variegata* may be mistaken for *N.* ×*rubrodisca*. Range extends from Newfoundland west to eastern Ontario, south to Nova Scotia, Connecticut, New Jersey, eastern Pennsylvania, New York, northern Michigan, northern Wisconsin, and eastern Minnesota.

Rare and endangered plant list: Vermont
alkalinity: mean 31.3 mg/l; range 3.5-57.5 mg/l; (8)
pH: mean 7.4; 6.7-8.2; (8)

3. *Nuphar variegata* Durand Figs. 6, 7, Map 8

Extremely common in slow moving waters throughout New England. This is one of the most common aquatic species in the region. Beal (1956) treated this taxon as *N. lutea* subsp. *variegata* (Durand) Beal. Range extends from Newfoundland and Labrador west to Yukon, south to Delaware, northeastern Pennsylvania, northern Ohio, northern Indiana, northern Illinois, South Dakota, Nebraska, and Montana.

alkalinity: mean 27.7 mg/l; range 2.0-132.5 mg/l; (186)
pH: mean 7.0; range 5.0-9.8; (181)

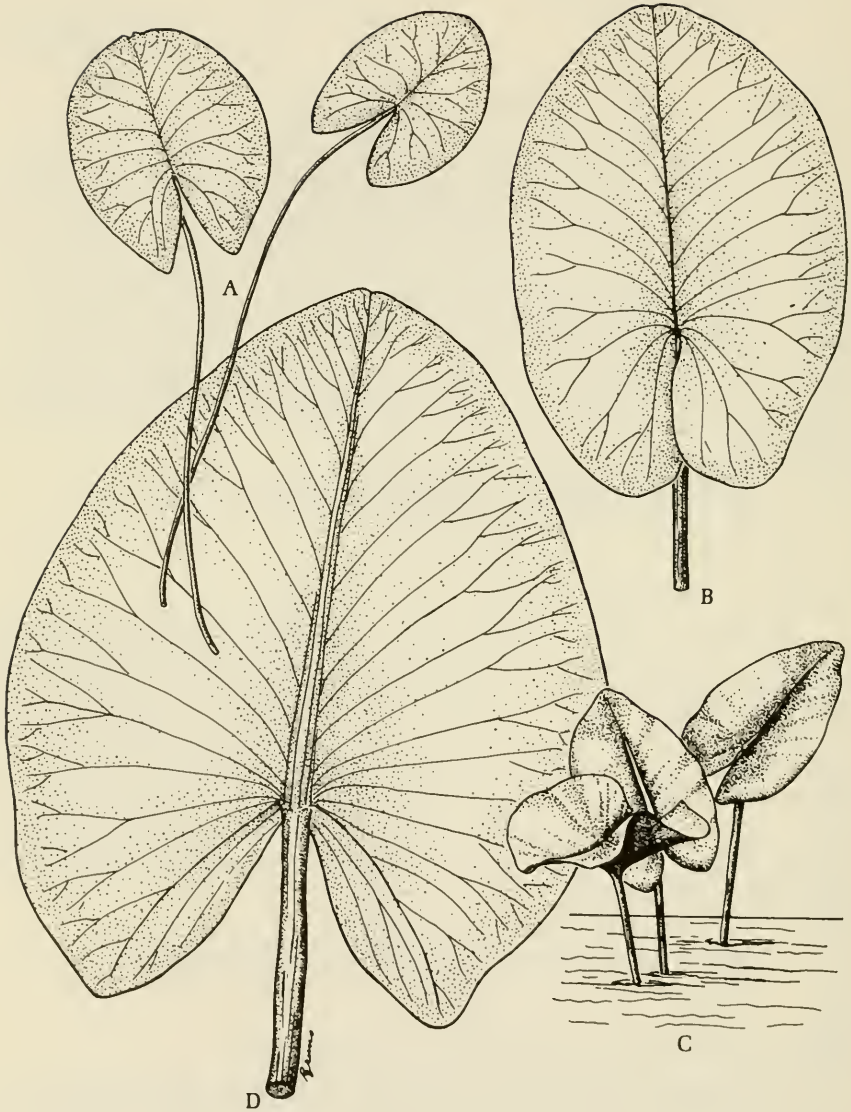


Figure 5.
Nuphar pumila: **A. leaves × ½.**
Nuphar* ×*rubrodisca: **B. leaf × ½.**
Nuphar advena: **C. habit showing characteristically emergent leaf blades. D. leaf × ½.**

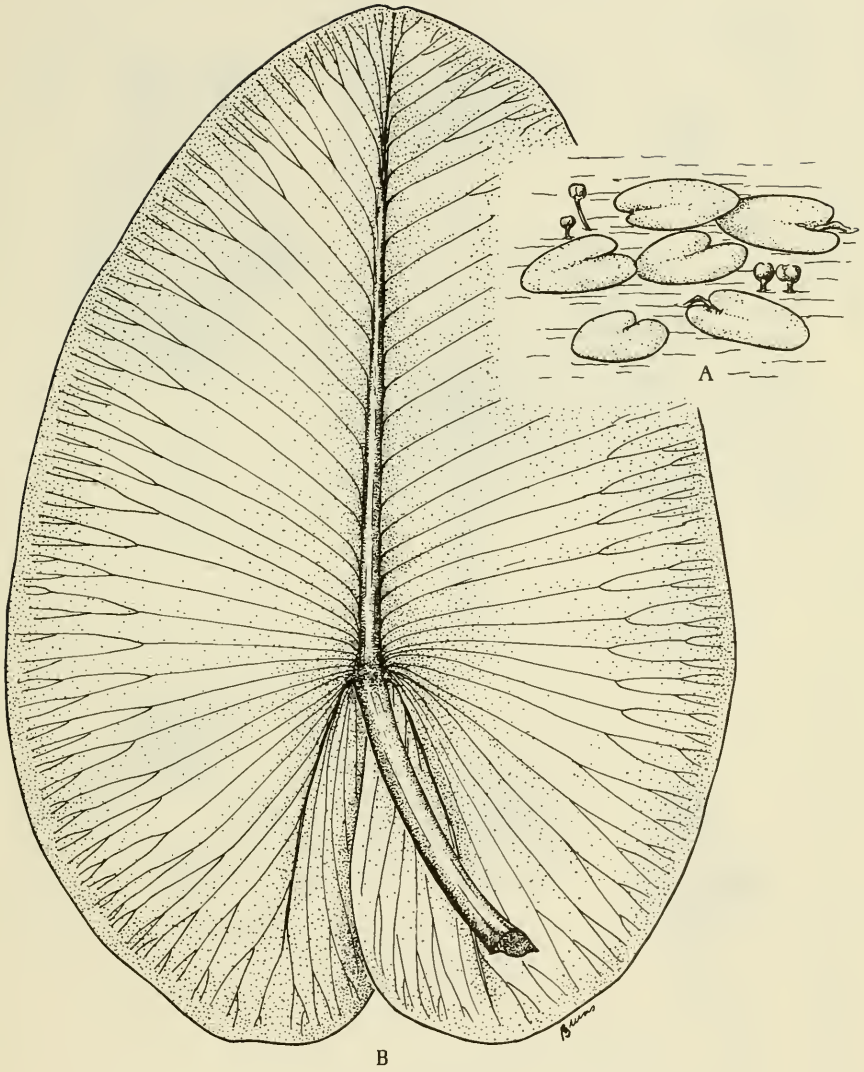


Figure 6.
Nuphar variegata: **A. habit showing characteristically floating leaves. B. leaf × ½.**

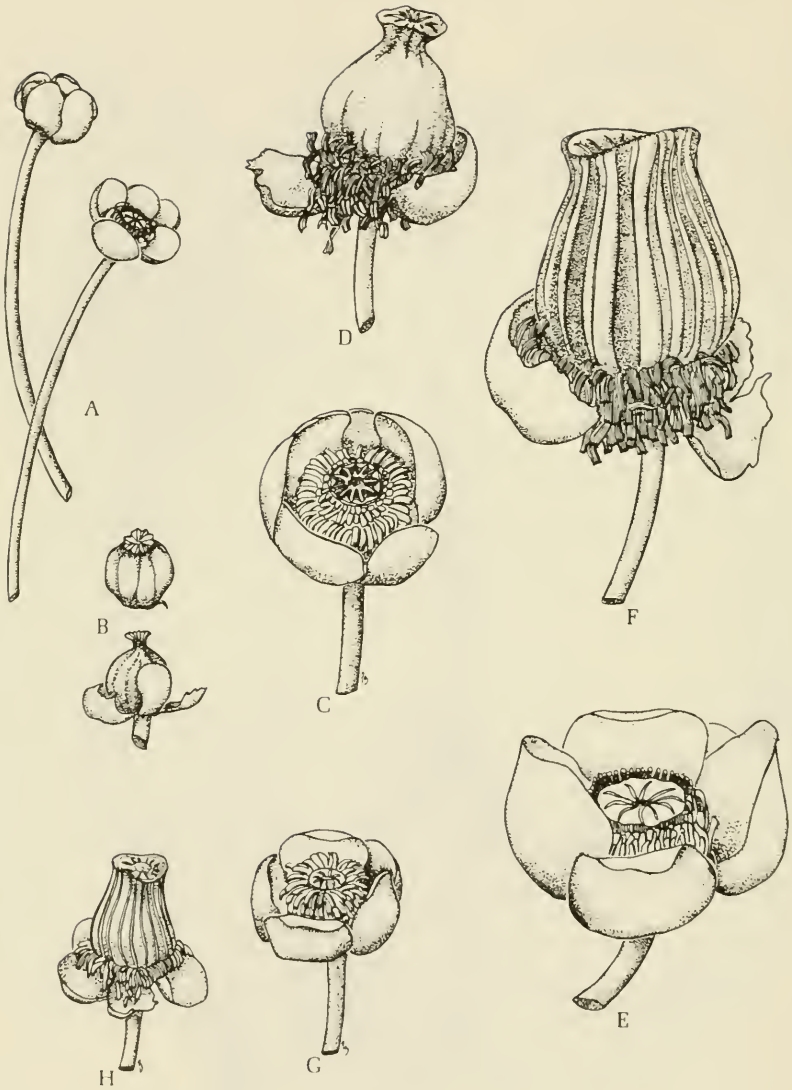
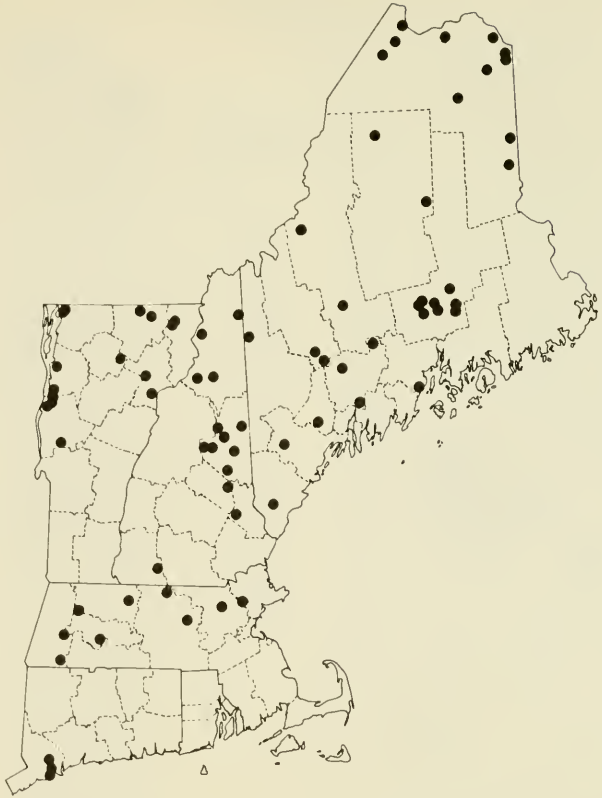
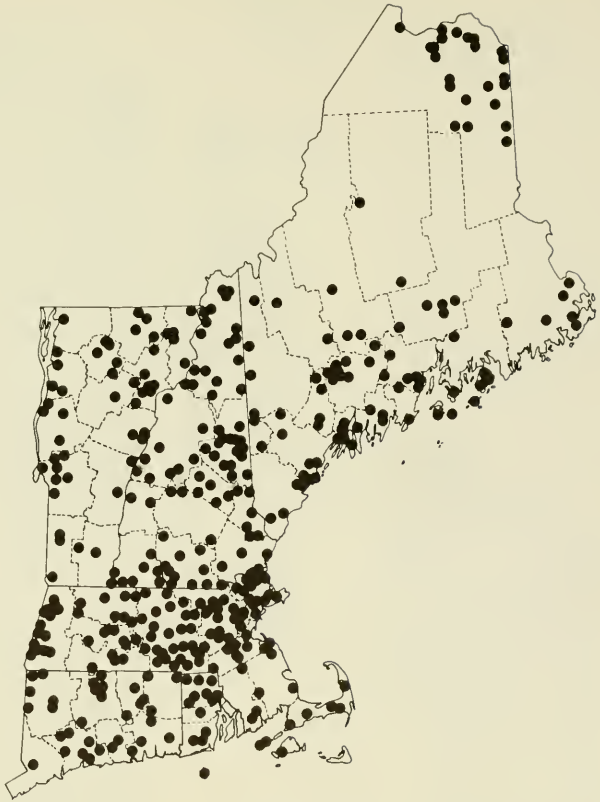


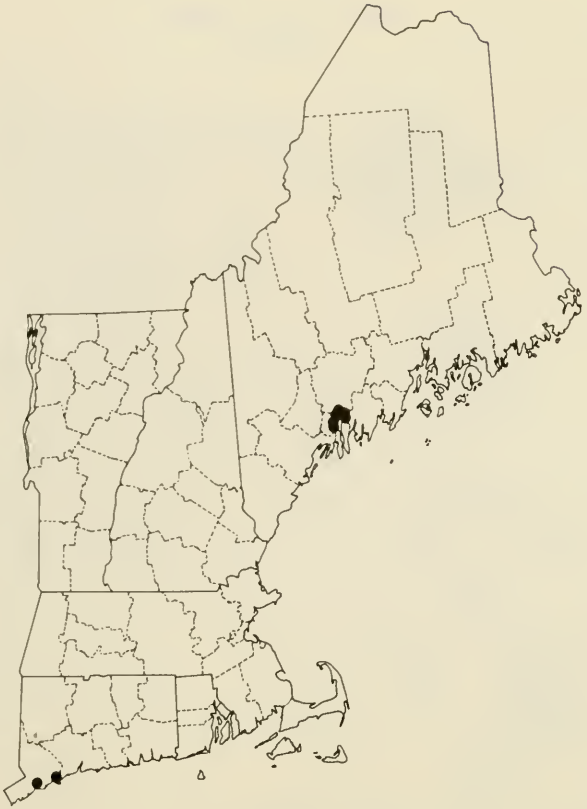
Figure 7.
Nuphar pumila: A. flowers × ½. B. fruits × ½. Both redrawn from Fassett.
Nuphar × *rubrodisca:* C. flower × 1. D. fruit × 1, redrawn from Fassett.
Nuphar variegata: E. flower × 1. F. fruit × 1. Both redrawn from Fassett.
Nuphar advena: G. flower × ½. H. flower × ½.



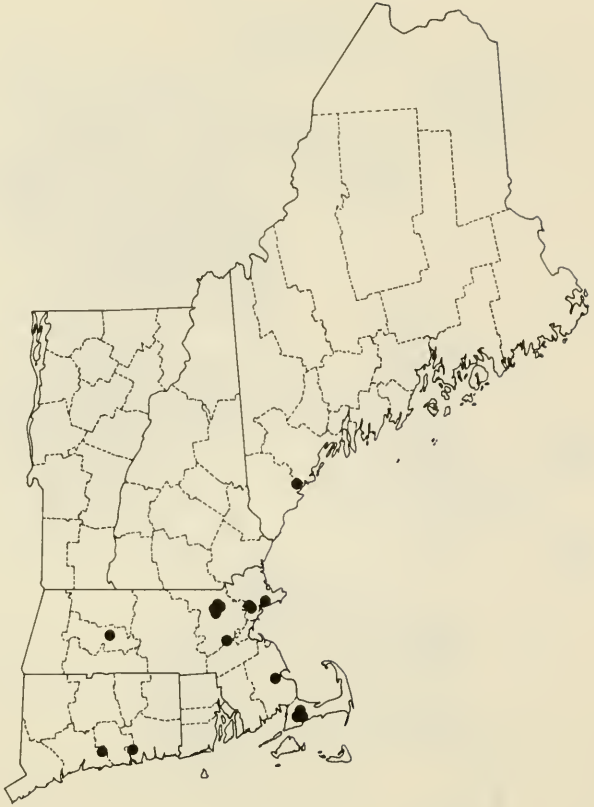
Map. 7.
Nuphar ×rubrodisca



Map 8.
Nuphar variegata



Map 9.
Nuphar advena



Map 10.
Nelumbo lutea

4. *Nuphar advena* (Ait.) Ait. f. Figs. 5, 7, Map 9

Locally abundant in the intertidal zone of Merrymeeting Bay, Sagadahoc Co., Maine and at a few locations along the coast of Connecticut. Beal (1956) recognized this taxon as *N. lutea* subsp. *macrophylla* (Small) Beal. Range extends from southern coastal Maine and coastal Connecticut west to central New York, Pennsylvania, Ohio, southern Michigan, southern Wisconsin, and southeastern Nebraska, south to Florida, Texas, and eastern Mexico.

NELUMBONACEAE

Nelumbo (Lotus, Water Chinquapin)

Perennial, arising from rhizomes; leaves large, circular, peltate, elevated high above the water (fig. 8) or floating; flowers large, showy; perianth sulfur-yellow, 12-25 cm broad, elevated above the water; stamens numerous, readily deciduous; carpels numerous, separate, imbedded in a broad, flat-topped receptacle; fruits indehiscent nutlets, often remaining in cavities of the woody receptacle.

1. *Nelumbo lutea* (Willd.) Pers. Fig. 8, Map 10

Widely scattered throughout southern New England in shallow ponds and along shores. The localities in New England are probably the result of introductions or escapes from cultivation. A large population occurs at the Great Meadows National Wildlife Refuge, Concord, Massachusetts. Ward (1977) notes that because the name *Nelumbo pentapetala* (Walt.) Fern. is of uncertain application, nomenclatural stability is better served by the use of *Nelumbo lutea* (Willd.) Pers. for the American Lotus. Range extends from southeastern Maine and Massachusetts west to New York, southern Ontario, Minnesota, and Iowa, south to Florida, Oklahoma, and eastern Texas.

CERATOPHYLLACEAE

Ceratophyllum (Coontail, Hornwort)

Perennial, free-floating submersed aquatic, lacking roots; leaves whorled, sessile or with short petioles, dichotomously divided into narrow segments (seedling leaves often opposite, simple); plants monoecious; flowers unisexual, axillary, one to several per node; fruit a 1-seeded, ovoid-oblong achene.

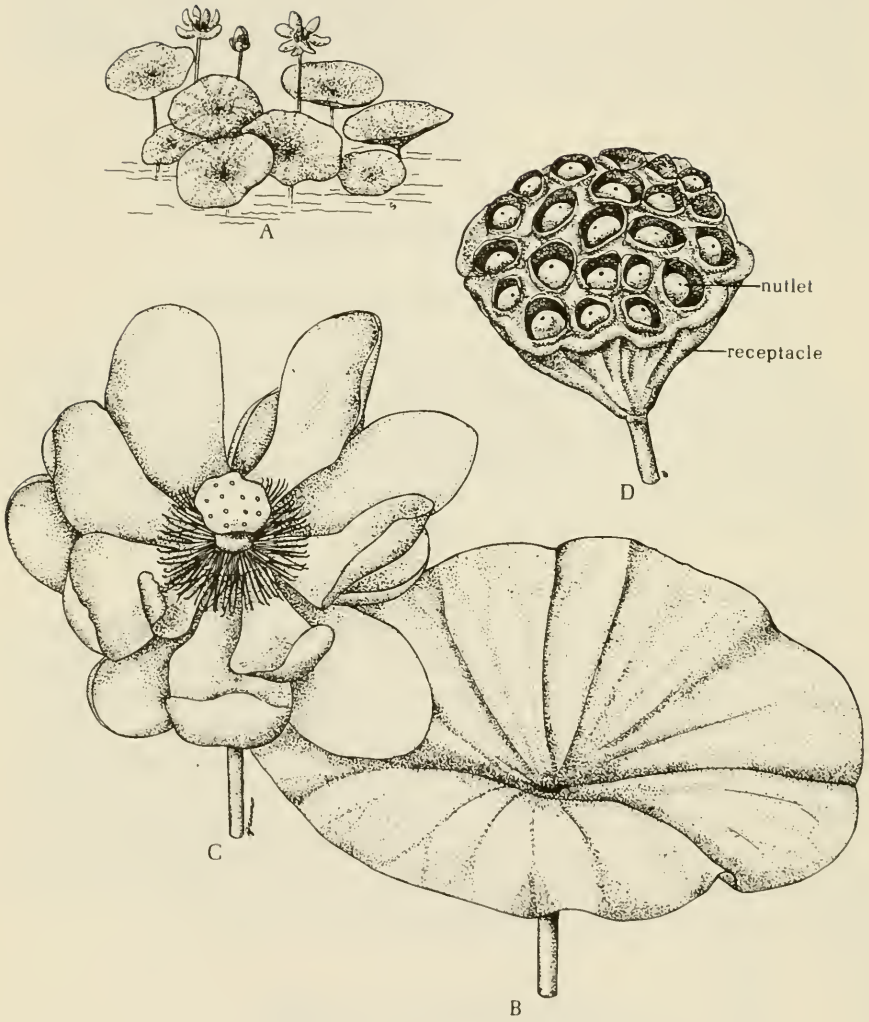


Figure 8.
Nelumbo lutea: **A. habit. B. leaf × ⅛. C. flower × ¼. D. woody receptacle with fruits × ¼.**

Key to Species

1. Principal leaves forked no more than two orders (no pair of ultimate segments results from more than two consecutive forkings of the leaf axis) (fig. 9B); leaf segments with distinct serrations (fig. 9B), the marginal teeth with wide bases (fig. 9C); fruit smooth or slightly warty, with two basal spines, marginal spines lacking (fig. 9D); first seedling leaves simple.
..... 1. *C. demersum*
1. Principal leaves often forked 3-4 orders (ultimate segment pairs result from up to 3-4 consecutive forkings of the leaf axis) (fig. 9E,F); leaf segments lacking distinct serrations, marginal teeth, when present, with narrow base (fig. 9F); first seedling leaves at least once divided.
..... 2. *C. echinatum*

1. *Ceratophyllum demersum* L. Fig. 9, Map 11

Common in shallow quiet waters throughout New England. Fruit on this and *C. echinatum* are uncommon, hence the vegetative characters are frequently used for identification. Range extends from Quebec and Maine west to northern British Columbia, south throughout the United States to Mexico.

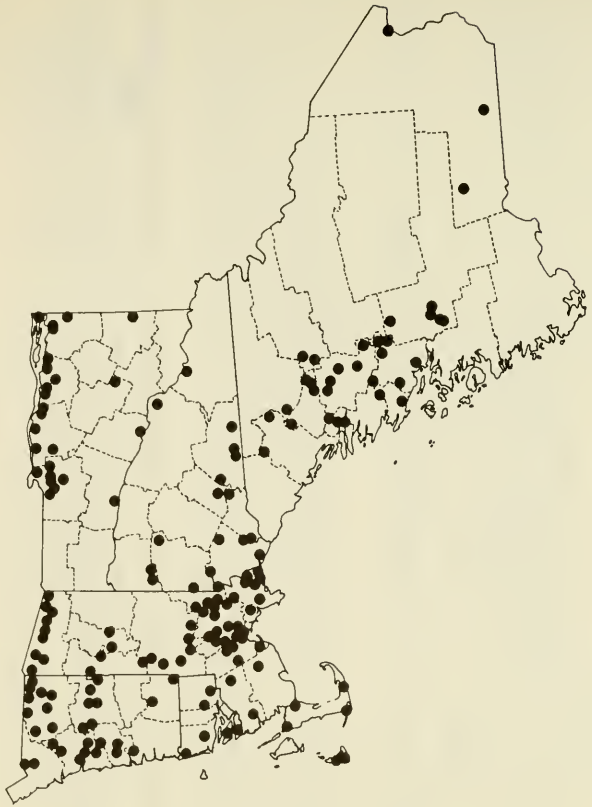
alkalinity: mean 51.6 mg/l; range 5.5-151.0 mg/l; (64)
pH: mean 7.3; range 5.9-8.9; (62)

2. *Ceratophyllum echinatum* A. Gray Fig. 9, Map 12

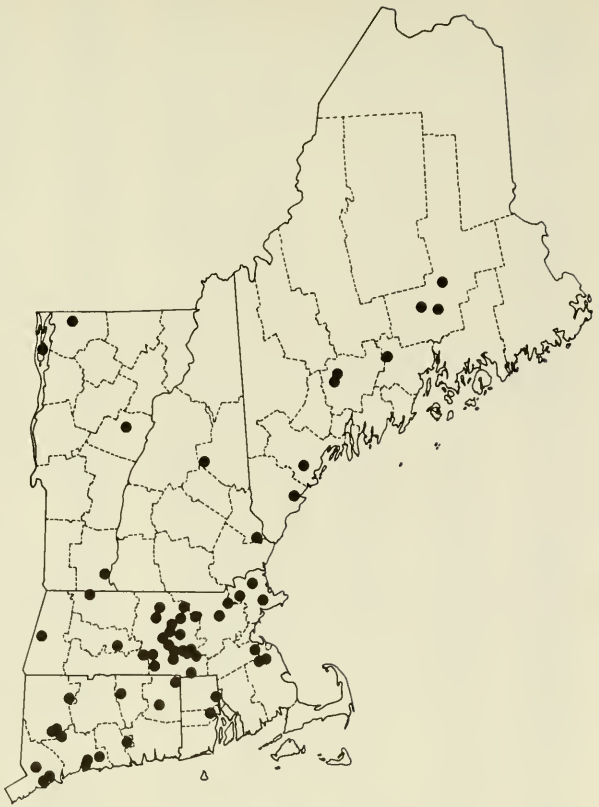
Locally abundant in quiet waters of southern New England. Although Lowden (1978) regards this taxon as conspecific with the Old World *C. muricatum* Cham., recent studies by Donald Les (pers. comm.) have supported the recognition of the two taxa as distinct species. Range extends from southwestern New Brunswick and central Maine west to New York, Ohio, Michigan, Illinois, and Minnesota, south to Florida, Iowa, Missouri, Arkansas, and Texas.
Rare and endangered plant list: Vermont

alkalinity: mean 25.1 mg/l; range 6.0-120.0 mg/l; (7)
pH: mean 6.8; range 5.7-7.8; (6)

Figure 9.
Ceratophyllum demersum: A. habit × ½. B. leaves × 1½. C. leaf segment showing broad-based marginal tooth × 4½. D. fruit × 3.
Ceratophyllum echinatum: E. leaf × 1½. F. spinulose leaf segment × 4½. G. fruit × 3.



Map 11.
Ceratophyllum demersum



Map 12.
Ceratophyllum echinatum

Literature Cited and Selected References

Aboy, H. E. 1936. A study of the anatomy and morphology of *Ceratophyllum demersum.* M. S. Thesis, Cornell Univ., Ithaca, N.Y.

Adams, F. S. 1969. Winter bud production and function in *Brasenia schreberi.* Rhodora 71: 417-433.

Baillon, H. 1871. Monographie des Nymphaeacées. Hist. Pl. 3: 77-104.

Bates-Smith, F. C. 1968. Chemotaxonomy of *Nuphar luteum* (L.) Sm. Phytochemistry 7: 459.

Beal, E. O. 1955. Taxonomic revision of the genus *Nuphar* Sm. Ph. D. dissertation, Iowa State University, Ames, Iowa.

Beal, E. O. 1956. Taxonomic revision of the genus *Nuphar* Sm. of North America and Europe. J. Elisha Mitchell Sci. Soc. 72: 317-346.

Beal, E. O. and R. M. Southall. 1977. Taxonomic significance of experimental selection by vernalization in *Nuphar* (Nymphaeaceae). Syst. Bot. 2: 49-60.

Beal, W. J. 1900. Notes on *Cabomba caroliniana* A. Gray. Bull. Torrey Bot. Club 27: 86.

Chrysler, M. A. 1938. The winter buds of *Brasenia.* Bull. Torrey Bot. Club 65: 277-283.

Conard, H. S. 1904. Phyllody in *Nelumbo.* Trans. Proc. Bot. Soc. Penn. 1: 350-351.

Conard, H. S. 1905. The water-lilies, a monograph of the genus *Nymphaea.* Publ. Carnegie Inst. Wash. No. 4.

Conard, H. S. 1916. *Nymphaea* and *Nuphar* again. Rhodora 18: 161-163.

Conard, H. S. 1936. Water-lilies, monocots or dicots? Amer. Bot. 42: 104-107.

Cutter, E. G. 1961. The inception and distribution of flowers in the Nymphaeaceae. Proc. Linn. Soc. London 172: 93-100.

DePoe. C. E. 1961. Relationships within the genus *Nuphar* Sm. (Nymphaeaceae) in the Carolinas. M. S. Thesis, North Carolina State University, Raleigh, NC.

DePoe, C. E. and E. O. Beal. 1969. Origin and maintenance of clinal variations in *Nuphar* (Nymphaeaceae). Brittonia 21: 15-28.

Dormer, K. J. and E. G. Cutter. 1959. On the arrangement of flowers on the rhizome of some Nymphaeaceae. New Phytol. 58: 176-181.

Farwell, O. A. 1936. The color of the flowers of *Nelumbo pentapetala.* Rhodora 38: 272.

Fassett, N. C. 1953. A monograph of *Cabomba.* Castanea 18: 116-128.

Fassett, N. C. 1953a. North American *Ceratophyllum.* Comun. Inst. Trop. Invest. Cient. 2: 25-45.

Fernald, M. L. 1919. *Nymphozanthus,* the correct name for the cow lilies. Rhodora 21: 183-188.

Fernald, M. L. 1934. The name of the American lotus. Rhodora 36: 23-24.

Gleason, H. A. 1947. The preservation of well-known binomials. Phytologia 2: 201-212.

Gray, A. 1837. Remarks on the structure and affinities of the order Ceratophyllaceae. Ann. Lyceum Nat. Hist. New York 4: 41-50.

Haines, R. W. and K. A. Lye. 1975. Seedlings of Nymphaeaceae. J. Linn. Soc., Bot. 70: 255-265.

Hall, T. F. and W. T. Penfound. 1944. The biology of the American Lotus, *Nelumbo lutea* (Willd.) Pers. Amer. Midl. Nat. 31: 744-758.

Heslop-Harrison, Y. 1955. *Nuphar* Sm. J. Ecol. 43: 342-364.

Jones, E. N. 1931. The morphology and biology of *Ceratophyllum demersum.* Univ. Iowa Stud. Bot. 13: 11-46.

Kosakai, H., M. F. Moseley, and V. I. Cheadle. 1970. Morphological studies of the Nymphaeaceae V. Does *Nelumbo* have vessels? Amer. J. Bot. 57: 487-494.

Lawson, G. 1889. On the Nymphaeaceae Trans. Roy. Soc. Canad. 6: 97-125.

Leeuwen, W. A. M. van. 1963. A study of the structure of the gynoecium of *Nelumbo lutea* (Willd.) Pers. Acta. Bot. Neerl. 12: 84-97.

Les, D. H. 1980. Contributions to the biology and taxonomy of *Ceratophyllum* in the eastern United States. M. S. Thesis, Eastern Michigan University, Ypsilanti, Mi.

Li, H. L. 1955. Classification and phylogeny of Nymphaeaceae and allied families. Amer. Midl. Nat. 54: 33-41.

Lowden, R. M. 1978. Studies on the submerged genus *Ceratophyllum* L. in the neotropics. Aquat. Bot. 4: 127-142.

Mackenzie, K. K. 1927. Proper use of the name *Nymphaea.* Rhodora 29: 234-237.

Miller, G. S. and P. C. Standley, 1912. The North American species of *Nymphaea.* Contr. U.S. Nat. Herb. 16: 63-108.

Mitchell, R. S. and E. O. Beal. 1979. Magnoliaceae through Ceratophyllaceae of New York State. Contributions to a flora of New York State II. New York State Mus. Bull. No. 435.

Morong, T. 1886. Revision of the North American species of *Nuphar* Bot. Gaz. 11: 164-169.

Moseley, M. F. 1961. Morphological studies of the Nymphaeaceae II. The flowers of *Nymphaea*. Bot. Gaz. 122: 233-259.

Muenscher, W. C. 1940. Fruits and seedling of *Ceratophyllum*. Amer. J. Bot. 27: 231-233.

Nash, G. V. 1907. Water-lilies and other aquatics: their relation to horticulture. J. N.Y. Bot. Gard. 88: 202-220.

Nieuwland, J. A. 1916. Habits of water-lily seedlings. Amer. Midl. Nat. 4: 291-297.

Pearl, R. 1907. Variation and differentiation in *Ceratophyllum*. Publ. Carnegie Inst. Wash. No. 58.

Porsild, A. E. 1939. *Nymphaea tetragona* Georgi in Canada. Canad. Field-Naturalist 53: 48-50.

Ramhorst, J. L. van and P. A. Florschutz. 1956. A new variety of *Cabomba caroliniana* Gray. Acta Bot. Neerl. 5: 342-343.

Raymond, M. and P. Dansereau. 1953. The geographical distribution of the bipolar Nymphaeaceae, *Nymphaea tetragona* and *Brasenia schreberi*. Mem. Jard. Bot. Montreal 41: 1-10.

Richardson, F. C. 1929. Morphological studies of the Nymphaeaceae IV. Structure and development of the flower of *Brasenia schreberi* Gmel. Univ. Calif. Publ. Bot. 47: 1-101.

Schneider, E. L. and L. A. Moore. 1977. Morphological studies of the Nymphaeaceae VII. The floral biology of *Nuphar lutea* ssp. *macrophylla*. Brittonia 29: 88-99.

Small, J. K. 1931. The water-lilies of the United States. J. N. Y. Bot. Gard. 32: 117-121.

Sohmer, S. H. 1975. The name of the American *Nelumbo*. Taxon 24: 491-493.

Sohmer, S. H. 1977. Aspects of the biology of *Nelumbo pentapetala* (Walter) Fernald, the American Lotus of the upper Mississippi. Trans. Wisconsin Acad. Sci. 65: 258-273.

Sohmer, S. H. 1978. The reproductive biology of *Nelumbo pentapetala* (Nelumbonaceae) on the upper Mississippi River II. The insects associated with the transfer of pollen. Brittonia 30: 355-364.

Sprague, T. A. 1928. The standard species of *Nymphaea* L. Rhodora 30: 53-59.

Taylor, H. J. 1927. The history and distribution of Yellow *Nelumbo,* Water Chinquapin or American Lotus. Proc. Iowa Acad. Sci. 34: 119-124.

Tokura, A. 1937. On the blooming of *Brasenia Schreberi* Gmel. (I). J. Jap. Bot. 13: 829-839.

Ward, D. B. 1977. *Nelumbo lutea,* the correct name for the American Lotus. Taxon 26: 227-234.

Williams, G. R. 1970. Investigations in the white water-lilies (*Nymphaea*) of Michigan. Michigan Bot. 9: 72-86.

Wood, C. E. 1959. The genera of the Nymphaeaceae and Ceratophyllaceae in the southeastern United States. J. Arnold Arbor. 40: 94-112.

ERRATUM — Aquatic Plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae

Page 2, lines 2-3 should read:
"adventitious roots opposite, finely dissected"

Station Bulletins of Botanical Interest

Grasses of New Hampshire. I. Tribes Poeae (Festuceae) and Triticeae (Hordeae). A. R. Hodgdon, G. E. Crow, and F. L. Steele. Bull. No. 512. 1979.

The Flora of Plum Island, Essex County, Massachusetts. M. J. McDonnell. Bull. No. 513. 1979.

Aquatic Vascular Plants of New England: Part 1. Zosteraceae, Potamogetonaceae, Zannichelliaceae, Najadaceae. C. B. Hellquist and G. E. Crow. Bull. No. 515. 1980.

Aquatic Vascular Plants of New England: Part 2. Typhaceae and Sparganiaceae. G. E. Crow and C. B. Hellquist. Bull. No. 517. 1981.

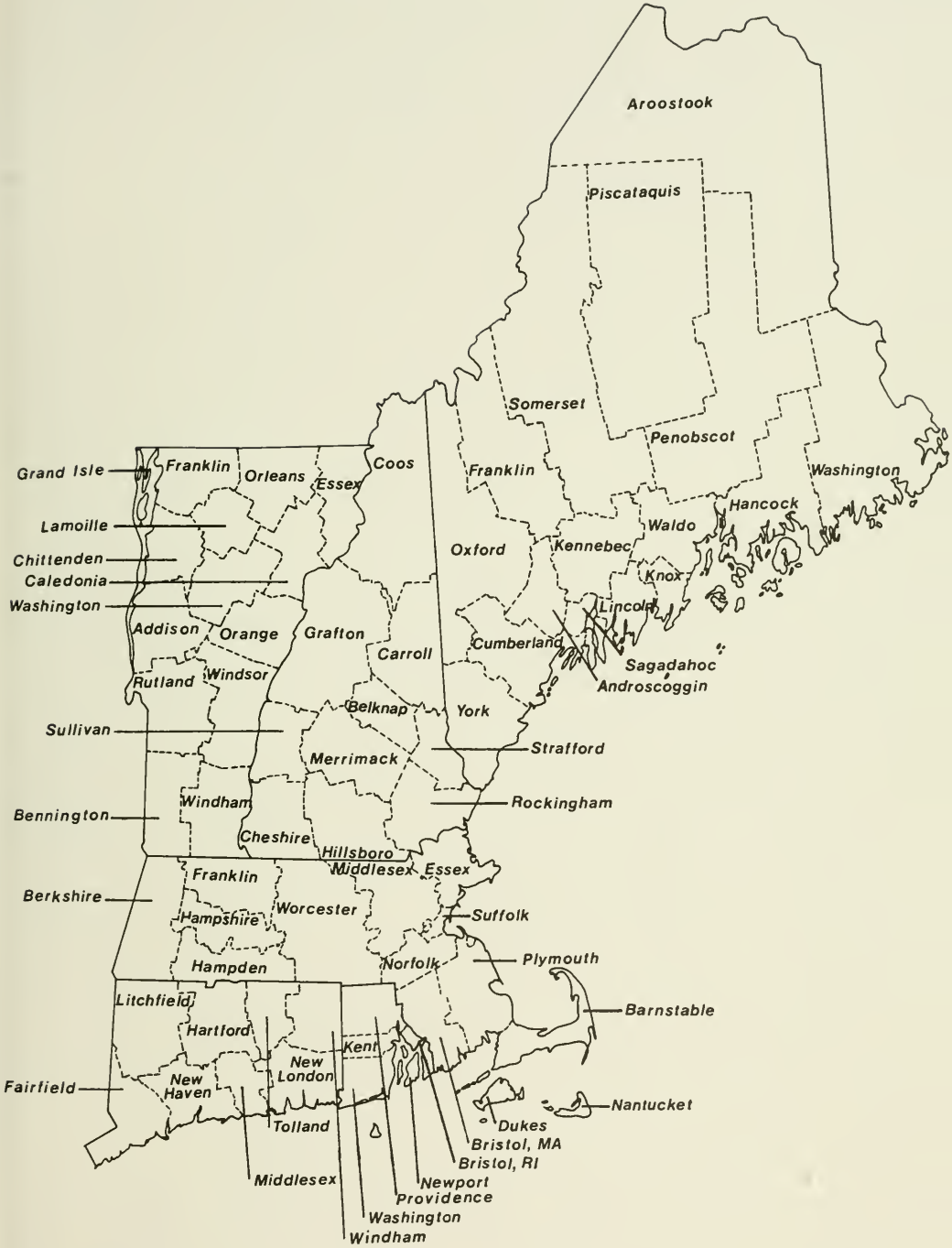
Aquatic Vascular Plants of New England: Part 3. Alismataceae. C. B. Hellquist and G. E. Crow. Bull. No. 518. 1981.

Aquatic Vascular Plants of New England: Part 4. Juncaginaceae, Scheuchzeriaceae, Butomaceae, Hydrocharitaceae. G. E. Crow and C. B. Hellquist. Bull. No. 520. 1982.

Aquatic Vascular Plants of New England: Part 5. Araceae, Lemnaceae, Xyridaceae, Eriocaulaceae, and Pontederiaceae. C. B. Hellquist and G. E. Crow. Bull. No. 523. 1982.

Aquatic Vascular Plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae. G. E. Crow and C. B. Hellquist. Bull. No. 524. 1983.

Hiker Traffic On and Near the Habitat of Robbins Cinquefoil, an Endangered Plant Species. R. E. Graber and G. E. Crow. Bull. No. 522. 1982.


Aroostook
Piscataquis
Somerset
Penobscot
Franklin
Washington
Hancock
Waldo
Kennebec
Knox
Lincoln
Cumberland
Sagadahoc
Androscoggin
Oxford
York
Grand Isle
Franklin
Orleans
Essex
Coos
Lamoille
Chittenden
Caledonia
Washington
Addison
Orange
Grafton
Carroll
Rutland
Windsor
Belknap
Sullivan
Merrimack
Strafford
Windham
Rockingham
Bennington
Cheshire
Hillsboro
Middlesex
Essex
Franklin
Berkshire
Worcester
Suffolk
Hampshire
Hampden
Norfolk
Plymouth
Litchfield
Barnstable
Hartford
Kent
New London
Fairfield
New Haven
Nantucket
Dukes
Tolland
Bristol, MA
Bristol, RI
Middlesex
Newport
Providence
Washington
Windham